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# Suborbital Research and Development Opportunities

## 2011 Next-Generation Suborbital Researchers Conference

March 1, 2011

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# Novel Strategies for Problem Solving

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- Discussion Topics
  - Space Life Sciences Overview
  - Strategic Initiatives
    - Visioning Workshop
    - Space Life Sciences Strategic Plan
    - Alliances Benchmark
    - Harvard Business School open collaboration/innovation
  - New Business Model
  - Opportunities for Suborbital Research



# Space Life Sciences Overview

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- Human health and performance in the space environment
  - Space medicine – health care and medical systems
    - Physiological and behavioral effects of spaceflight
  - R&TD on weightlessness, isolation
  - Space environmental monitoring
    - Radiation, air/water, microbiology/toxicology, food systems
  - Human Factors
    - Human centered design, ergonomics, biomechanics, food systems
- Human-centered risk assessment and risk mitigation
- Space Flight Human System standards and requirements
- Host of the ESMD/Human Research Program Office
- Strategy formulation and innovation management



# Strategic Initiatives

## 2006 Visioning Workshop

### HQ lead office for life sciences

- Assumption:
  - Low likelihood of returning in next 10 years
- Characteristics
  - Central budget, Fundamental research, NRA's, grants
  - NASA funded partnerships
  - Some institutional costs provided by program

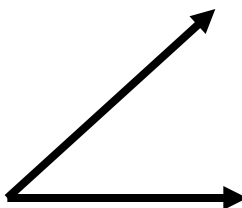


### Current state

- Assumptions
  - Current resources, no growth
- Characteristics
  - Focused R+D on TRL/CRL 4-6
  - Inflation, escalation erode content
  - Little low TRL/CRL work

### Minimum necessary services

- Assumptions
  - Program need to reduce costs
  - Program buy it by the yard
- Characteristics
  - Outsourcing
  - Minimal R&D
  - Few partners



### Partner/shared services model

- Assumptions
  - Core capabilities not funded by institution
  - Rapid external pace of change
- Characteristics
  - Consulting, high-end expertise,
  - Partners fill in low CRL/TRL work
  - Leverage with partners



# Strategic Initiatives

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## 2006 Visioning Workshop Outcome:

- Need to shift from traditional strategies and philosophies to partnerships and collaboration to achieve goals
- Break out session discussions provided basis for key strategies and goals in strategic plan

### **Partner/shared services model**

- Assumptions
  - Core capabilities not funded by institution
  - Rapid external pace of change
- Characteristics
  - Consulting, high-end expertise,
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  - Leverage with partners



# Strategic Initiatives

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- 2007 SLSD Strategic Plan
  - Mission Statement

“To optimize human health and productivity for space exploration”
  - Vision Statement

"To become the recognized world leader in human health, performance and productivity for space exploration”
  - Strategic Goals
    - Manage balanced internal/external portfolio
    - Drive health innovations
    - Drive human system integration innovations
    - Educate and inspire



# Strategic Initiatives

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- SLSD Strategic Plan 2007
  - Key strategies for driving innovation
    - Develop/implement an improved business model (collaborative approaches and tools)
    - **Establish strategic alliances/collaborative efforts**
    - **Adopt an integrated human system risk management approach**
    - Enhance internal and external communications
    - **Establish a virtual center to achieve vision**



# Strategic Initiatives

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- 2008-2010 Alliances Benchmark
  - Developed benchmark process to assess best practices for identifying, establishing, and managing alliances and collaborations
  - 20 organizations interviewed
    - Government agencies
    - Industry
    - Academia





# Strategic Initiatives

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- 2008-2010 Alliances Benchmark (cont.)
  - Responses: Why Collaborate?
    - **100% response: critical to innovate**
    - Enhance portfolios by supplementing internal core capabilities with external capabilities
    - Find innovative solutions quickly and efficiently in a rapidly changing environment
  - Critical Success Factors
    - **100% response: address cultural issues: “Not invented here”**
    - Unifying vision, alignment with strategy, clearly defined objectives
    - Annual planning/gap analysis



# Strategic Initiatives

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- Summary
  - Visioning exercise and strategic plan
  - Alliances benchmark 2008-2010
  - HBS collaborative innovation models and collaborative projects 2008-2010
  - Open innovation pilot project 2008-2010
  - Virtual center for collaboration established 2010: NASA Human Health and Performance center
  - Pursue collaborative research models 2011
  - Develop Strategic Framework for Innovation 2011



# New Business Model

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- A new business model is required to infuse open collaboration/innovation tools into existing models for research, development and operations (research announcements, procurements, SBIR/STTR etc)
- Components of a new model
  - Strategic visioning and planning with annual review
  - Portfolio definition – what work are you trying to achieve?
  - Portfolio analysis to determine when to collaborate and the optimal collaborative strategy
  - Establish decision framework for using novel and established approaches (tools)
  - Evaluate with metrics / reassess on an annual basis
  - Organize to fully implement collaborative model – NASA Human Health and Performance Center (NHHPC)



# Portfolio Definition

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- Human System risks for space flight (our portfolio of work)
  - Evidence based risk management system
    - Space Flight Human System Standards
    - 65 human system risks
    - Human System Risk Board formed April 2008 –integrates research and operations—decisions made by one entity
  - Developed Risk Management Analysis Tool (RMAT)
    - Captures vertical “standards to deliverables” process
    - Links risks for common elements (e.g. low vitamin D levels common to several risks)
  - Subject matter experts (risk owners) identify gaps in their research and technology portfolio)
  - Gaps became opportunities for open collaborative solutions



# Portfolio Analysis

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- Portfolio mapping – Dr. Gary Pisano, Harvard Business School (HBS)
  - “Which Kind of Collaboration is Right for You” – Harvard Business Review, December 2008
- Workshop conducted by Dr. Pisano with NASA – Wyle leadership team July 2009
  - Analyzed 12 gaps for collaborative opportunity, those that mapped to open innovation quadrant selected for pilot projects



# Portfolio Analysis: Mapping - Models of Collaboration

## The Four Ways to Collaborate

There are two basic issues that executives should consider when deciding how to collaborate on a given innovation project: Should membership in a network be open or closed? And, should the network's governance structure for selecting problems and solutions be flat or hierarchical? This framework reveals four basic modes of collaboration.

|   |   |               |        |
|---|---|---------------|--------|
| <b>Innovation Mall</b><br>A place where a company can post a problem, anyone can propose solutions, and the company chooses the solutions it likes best<br><i>Example:</i> InnoCentive.com website, where companies can post scientific problems    | <b>Innovation Community</b><br>A network where anybody can propose problems, offer solutions, and decide which solutions to use<br><i>Example:</i> Linux open-source software community   | PARTICIPATION | Open   |
| <b>Elite Circle</b><br>A select group of participants chosen by a company that also defines the problem and picks the solutions<br><i>Example:</i> Alessi's handpicked group of 200-plus design experts, who develop new concepts for home products | <b>Consortium</b><br>A private group of participants that jointly select problems, decide how to conduct work, and choose solutions<br><i>Example:</i> IBM's partnerships with select companies to jointly develop semiconductor technologies |               | Closed |
| GOVERNANCE  |   |               |        |
| Hierarchical  | Flat  |               |        |

HARVARD BUSINESS REVIEW • DECEMBER 2008

From Gary Pisano, Harvard Business School

Space Life Sciences  
Exploring Space | Enhancing Life



# Suborbital Research and Development Opportunities

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- Physiological characterization of first few minutes of space flight
  - Early changes may be important to chronic changes
    - Cardiology
    - Intracranial pressure
  - Wider range of medical conditions
    - Better inform medical guidelines and standards for government programs
  - Easier access – allows physiological monitoring equipment to be worn
  - These first few minutes represent a data gap in government programs



# Suborbital Research and Development Opportunities

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- Environmental monitoring
  - ISS will fly until 2020 and next generation environmental monitoring equipment will be needed
    - Small, portable, reliable, replaceable
    - Air, water, microbiology, toxicology
    - Suborbital vehicle could serve as an initial testbed for these devices





# Suborbital Research and Development Opportunities

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- Shared database

- Centralized database for various data elements
  - Non-attributable medical data
  - Physiologic responses to flight
  - Medical issues during flight
- Why?
  - Standardized data collection benefits risk management for suborbital operators
  - Similar database not available in commercial aviation
  - Inform medical standards of government operators



# Suborbital Research and Development Opportunities

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- Novel problem solving techniques and collaboration
  - Public – private partnerships for prizes
  - Can facilitate open innovation prizes among partners
  - Will briefly discuss results of open innovation challenges at NASA
- NASA Human Health and Performance Center
  - opportunity for new members to participate in knowledge sharing, best practices, collaborative projects
  - Will briefly discuss
  - No fees or agreements to participate



# Backup Slides

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# Open Innovation

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- Open innovation and collaboration– four pilot projects
  - **InnoCentive**- posts individual challenges/gaps to their established network of solvers (200,000)
    - financial award if the solution is found viable by the posting entity
  - **Yet2.com**- acts as an actual technology scout bringing together buyers and sellers of technologies
    - Option to develop partnerships
  - **TopCoder** - open innovation software company with a large network of solvers (200,000)
    - variety of skill-based software coding competitions
  - **NASA@work**-internal collaboration platform leveraging expertise found across NASA's 10 centers



# NASA Pavilion on InnoCentive



## NASA Innovation Pavilion



Welcome to the **NASA Innovation Pavilion**, which provides Solvers the opportunity to develop innovative solutions to the unique challenges faced by NASA in achieving its mission to pioneer the future of space exploration, scientific discovery, and aeronautics research. Solutions to these challenges will not only benefit space exploration, but may also further the development of commercial products and services in the fields of health and medicine, industry, consumer goods, transportation, public safety, computer technology, and environmental resources.

[Johnson Space Center](#)

[Langley Research Center](#)

[Glenn Research Center](#)

### Centers Participating in the NASA Innovation Pavilion

#### Johnson Space Center

The Johnson Space Center has been home to all U.S. human space flight programs. Our scientists and engineers are engaged in research and technology development projects encompassing human health and performance, life sciences, and aerodynamics, mechanical, electrical, industrial, propulsion, chemical, and computer engineering. We are seeking new and creative ideas to enable our success as we venture beyond low Earth orbit and further explore the universe.

PAUSE



# 2900 Solvers – 80 countries





# InnoCentive Pilot: Challenge Data and Statistics

| Challenge Title   | Ctr                   | Posted            | Deadline         | Proj<br>Rms | Sub        | Award<br>Date      | Award<br>Amount     |
|---|-----------------------|-------------------|------------------|-------------|------------|--------------------|---------------------|
| Improved Barrier Layers ...<br>Keeping Food Fresh in Space        | JSC -<br>SLSD         | 12/18/2009        | 2/28/2010        | 174         | 22         | 5/7/2010           | \$11,000            |
| Mechanism for a Compact<br>Aerobic Resistive Exercise<br>Device   | JSC -<br>SLSD         | 12/18/2009        | 2/28/2010        | 564         | 95         | 5/14/2010          | \$20,000            |
| <b>Data-Driven Forecasting of<br/>Solar Events</b>                | <b>JSC -<br/>SLSD</b> | <b>12/22/2009</b> | <b>3/22/2010</b> | <b>579</b>  | <b>11</b>  | <b>5/13/2010</b>   | <b>\$30,000</b>     |
| Coordination of Sensor<br>Swarms for Extraterrestrial<br>Research | LRC                   | 2/27/2010         | 4/26/2010        | 423         | 37         | 6/4/2010           | \$18,000 (3)        |
| <b>Medical Consumables<br/>Tracking</b>                           | <b>GRC</b>            | <b>5/17/2010</b>  | <b>7/27/2010</b> | <b>365</b>  | <b>56</b>  | <b>in progress</b> | <b>\$15,000 (3)</b> |
| Augmenting the Exercise<br>Experience                             | JSC -<br>SLSD         | 5/27/2010         | 7/27/2010        | 229         | 18         | 9/20/2010          | \$10,000            |
| <b>Simple Microgravity Laundry<br/>System</b>                     | <b>JSC -<br/>EA</b>   | <b>5/27/2010</b>  | <b>7/27/2010</b> | <b>598</b>  | <b>108</b> | <b>9/21/2010</b>   | <b>\$7,500</b>      |





# Open Innovation – Yet2.com

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## Yet2.com

- NASA technical needs chosen based on portfolio mapping exercise
- Yet2 works with NASA technical need owner to develop statements and facilitate initial communication with contacts
- 6 technical needs in process
  - Phase1
    - Bone Imaging
      - A clinically-useful technology with enough sensitivity to assess the microstructure of "spongy" bone that is found in the marrow cavities of whole bones.
    - Water Monitoring (2 components)
      - Preventing growth of and removing microorganisms and bio-films from a potable water system
      - Real-time analysis and reporting of water-borne microorganisms
    - Radioprotectants for humans exposed to chronic and acute radiation
      - Biological, pharmaceutical, or dietary countermeasures to act as radioprotectants for humans exposed to higher doses of radiation, both chronic and acute





# Bone Imaging Contacts

yet2.com® Search  Technologies ☒ Technology Needs [Browse Technologies](#) [Browse Technology Needs](#)

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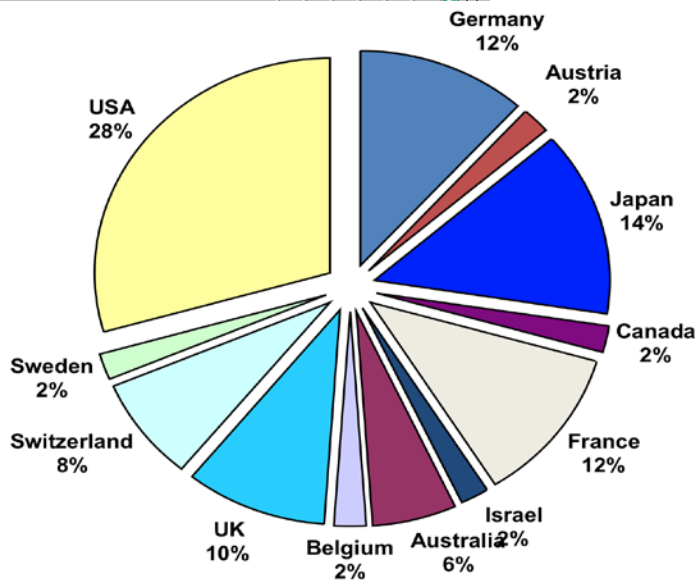
**Seeking: Accurate measurement techniques for deep-bone density and structure**

**Description**

**OVERVIEW**  
We are seeking a clinically-useful technology with enough sensitivity to assess the microstructure of "spongy" bone that is found in the marrow cavities of whole bones. However, this technology must be for skeletal sites surrounded by layers of soft tissues, such as the spine and the hip. Soft tissue interferes with conventional imaging and using a more accessible area -- for example, the wrist or the ankle of limbs-- as a proxy for the less accessible skeletal regions, will not be accurate. A non-radioactive technology is strongly preferred.

**BACKGROUND**  
The structural arrangement of tiny bones (the trabecular microarchitecture) that are found in the marrow cavity of whole bones is difficult to image. Trying to image the trabecular microarchitecture of the spine or the hip is complicated because of the noise produced by surrounding soft tissue. Studies have reported profound changes to the bone marrow compartments of the hip and spine under certain stresses and conditions. Unlike commonly recognized bone diseases such as osteoporosis, the skeletal changes we have observed are targeted to specific sites of the skeleton. This suggests that the factors -- that cause the bone mineral loss we are seeing -- do not circulate through the body, but are local to the affected skeletal site -- the spine and hip in particular. In other words, measurements conducted at a site at the periphery of the skeleton may not reflect or predict changes at a site located more centrally in the skeleton. Technologies have emerged for the assessment of the trabecular microarchitecture of bone structures. These high-resolution methods, however, are being developed for peripheral skeletal sites (wrist and ankle) because bones are closer to the surface and the signal can be detected better (greater "signal to noise") than for bones surrounded by layers of soft tissue. A similar

|             |    |
|-------------|----|
| Germany     | 6  |
| Austria     | 1  |
| Japan       | 7  |
| Canada      | 1  |
| France      | 6  |
| Israel      | 1  |
| Australia   | 3  |
| Belgium     | 1  |
| UK          | 5  |
| Switzerland | 4  |
| Sweden      | 1  |
| USA         | 15 |
| Total       | 51 |





# Open Innovation- TopCoder

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- Opportunity presented to NASA by Harvard Business School
  - Research project to compare outcomes of collaborative and competitive teams
  - NASA provided the problem statement
    - Optimize algorithm that supports medical kit design
- Competition began on 11/04/2009 and lasted approximately 10 days
  - 2800 solutions were submitted by 480 individuals
  - Useful algorithm developed and incorporated into NASA model
- Team felt this process was more efficient than internal development
- Next steps – SOMD (Jason Crusan) has formed a Tournament Lab with HBS and TopCoder to seek many novel optimization algorithms for ISS



# NASA@Work

**NASA@work**  
Communicate. Collaborate. Come Together.

CHALLENGES HOME | SUGGEST A CHALLENGE | INFO EXCHANGE | MANAGE | MY ACCOUNT | HELP | CORPORATE INTRANET

[Challenge Activity Dashboard](#)

**NASA@work Challenges (20 of 20 total)**

Search Challenges & Discussions:  [Search](#) [Switch To Summary View](#)

SORT By: Deadline in Descending Order FILTERS - By Status: Pending, Open, Under Eval By Tag: Technology Development

Showing 20 out of 20 results

**If and When Life Is Discovered on Mars, How Can We Determine If It is Truly Indigenous Mars Life?**  
Challenge Award: **\$200 USD** Challenge 429 Challenge Owner: **Levine, Joel S. (LARC-E303)** - [Edit This Challenge](#)

Proposals are requested for protocols that would increase the certainty that any life discovered during missions to Mars is indigenous to Mars and does not result from man's exploration of the planet surface ('Forward Contamination'). Input from biologists and experts in habitability and planetary protection is particularly welcome.

[Read Details](#) [Discuss Challenge](#)



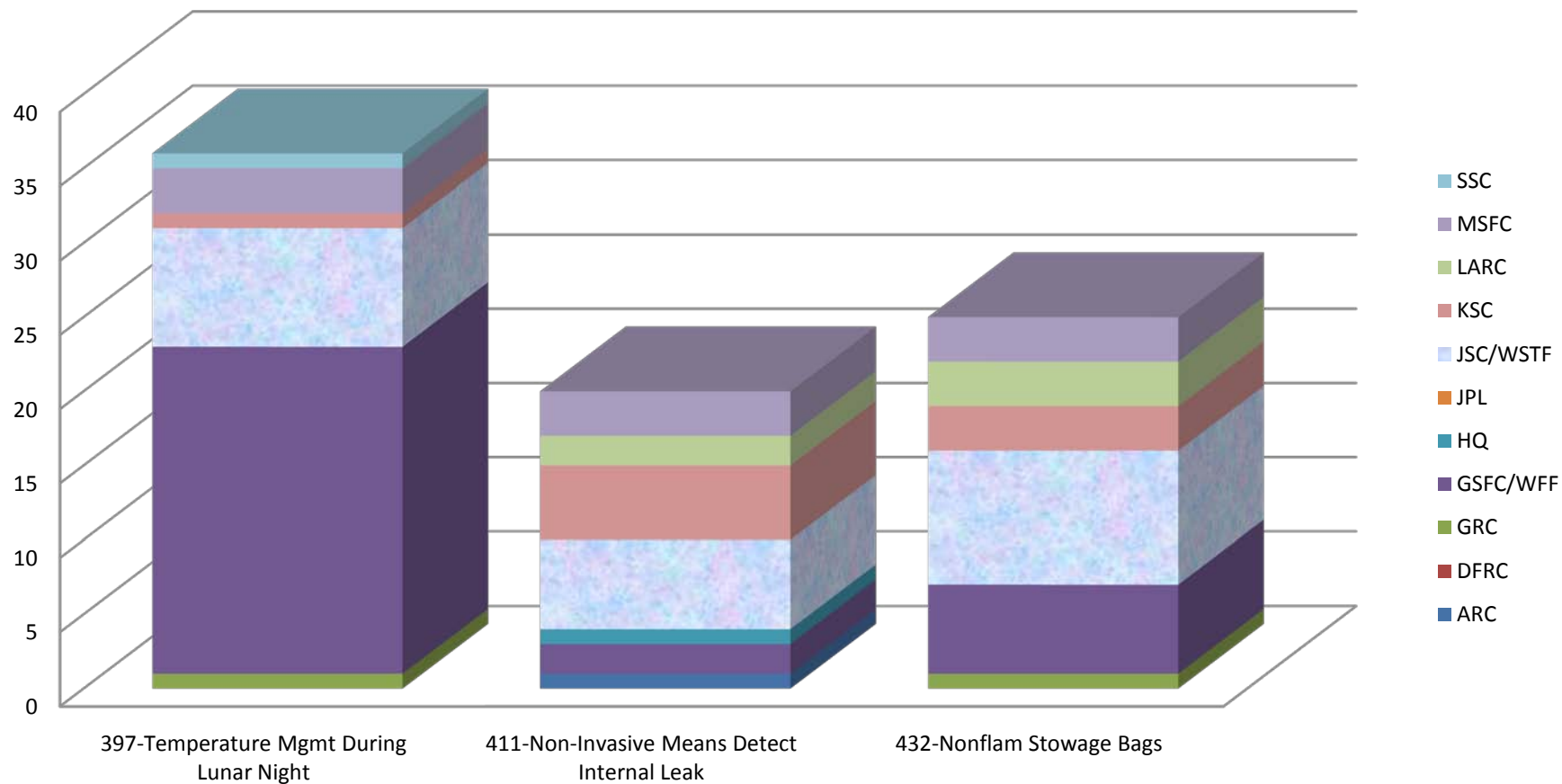
# NASA@Work Center Participation

| Center             | Challenges Posted | Registered Solvers | Discussion Posts | Participants |
|--------------------|-------------------|--------------------|------------------|--------------|
| Ames               | 3                 | 310                | 18               | 11           |
| Dryden             | 0                 | 146                | 13               | 9            |
| Glenn              | 1                 | 467                | 12               | 9            |
| Goddard            | 2                 | 564                | 101              | 13           |
| Jet Propulsion Lab | 2                 | 1                  | 0                | 0            |
| Johnson            | 3                 | 1380               | 46               | 29           |
| Kennedy            | 2                 | 1067               | 73               | 39           |
| Langley            | 4                 | 425                | 31               | 12           |
| Marshall           | 0                 | 700                | 23               | 14           |
| Stennis            | 2                 | 148                | 22               | 5            |
| Headquarters       | 1                 | 267                | 15               | 9            |



# NASA@Work

## JSC Challenges





# NASA@Work

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- Early Findings
  - Connected 10 NASA centers horizontally (peer to peer)
  - Connected areas of expertise previously untapped
  - Enthusiasm for the pilot and willingness to use again
  - Positive comments about NASA trying a new business model
  - Solid solutions for some technical problems



# NASA Human Health and Performance Center

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- Established October 18, 2010 – overarching goals:
  - Integrate human health and performance efforts across NASA and with member organizations
  - Advance human system research and technology, process, and practice innovations
  - Facilitate collaborative projects that enable and advance human spaceflight capabilities, and address national and global human health and performance needs
  - Resource for integration and coordination of NASA proposals, risk assessments, and requirements to inform the human exploration missions and technology needs



# NASA Human Health and Performance Center

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- Membership
  - 70 + members: <http://nhhpc.nasa.gov>
  - Seven NASA Centers
  - International Space Station partners: JAXA, DLR
  - Government orgs: FAA, GSA, USAF Research Labs, two NIH Centers, FDA, USAID
  - Academia: FAA COE (Stanford), MIT, UTMB, Tufts, Clemson
  - Corporate: Philips, Johnson & Johnson, Procter & Gamble, General Mills, Nike, GE, InnoCentive, Yet2.com, Cazneau, Pitney Bowes, UnitedHealth Group
  - Nonprofits: Mozilla, Southwest Research Institute, National Center for Human Performance, San Diego Zoo, Draper Lab
- First Workshop January 19, 2011 – Collaborative Innovation: Strategies and Best Practices